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*Indian Standard*

METHODS FOR  
DETERMINATION OF FLAMMABILITY AND  
FLAME RESISTANCE OF TEXTILE FABRICS

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**BUREAU OF INDIAN STANDARDS**  
MANAK BHAVAN, 9 BAHADUR SHAH ZAFAR MARG  
NEW DELHI 110002

# Indian Standard

## METHODS FOR DETERMINATION OF FLAMMABILITY AND FLAME RESISTANCE OF TEXTILE FABRICS

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# *Indian Standard*

## METHODS FOR DETERMINATION OF FLAMMABILITY AND FLAME RESISTANCE OF TEXTILE FABRICS

### 0. FOREWORD

**0.1** This Indian Standard was adopted by the Indian Standards Institution on 15 November 1986, after the draft finalized by the Chemical Methods of Test Sectional Committee had been approved by the Textile Division Council.

**0.2** The flammability is one of the important properties of textile materials, besides characteristics like combustion, thermal degradation, smouldering, after glow, smoke and toxicity. With the increasing awareness of fire hazards and promulgation of rules and regulations by several advanced countries, the development of flammability standard needs no emphasis.

**0.3** While preparing this standard, considerable assistance has been derived from the following:

- a) ASTM D 1230-1972 'Standard test method for flammability of clothing textiles' issued by the American Society for Testing and Materials.
- b) BS 3119 : 1959 'Method of test for flameproof materials' issued by the British Standards Institution.

**0.4** For the purpose of deciding whether a particular requirement of this standard is complied with, the final value, observed or calculated, expressing the result of test, shall be rounded off in accordance with IS : 2-1960\*. The number of significant places retained in the rounded off value should be the same as that of the specified value in this standard.

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### 1. SCOPE

**1.1** This standard prescribes two methods for determining the flammability and flame resistance of textile fabrics. It applies to all types of textile fabrics, clothing and garments whether woven, knitted, bonded, laminated or surface coated.

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\*Rules for rounding off numerical values (*revised*).

## 2. APPLICATION

**2.1 Method A** based on vertical flame test is recommended for evaluating flame resistance of all types of textile fabrics. Method B based on 45° inclination flame test covers the evaluation of flammability of textile clothing and textiles intended to be used in clothing.

**2.1.1** The methods described in this standard are not applicable to rugs and carpets and for interior fabrics used for passenger vehicles.

## 3. DEFINITIONS

**3.0** For the purpose of this standard, the following definitions shall apply.

**3.1 Flammability** — The characteristics of a material which pertain to its relative ease of ignition and relative ability to sustain combustion.

**3.2 Flame** — As related to textile flammability, a hot, luminous zone of gas or matter in gaseous suspension, or both, that is, undergoing combustion, which is relatively constant in size and shape and which produces a relatively low heat flux.

**3.3 Ignition** — Flaming of the specimen for a period of 1 s or more after the removal of the igniting source.

**3.4 Flashing** — The sudden transition of a state of total surface involvement in a fire of combustible material within a compartment.

**3.5 Flame-Retardant** — A chemical used to impart flame resistance.

**3.6 Flame-Retardant Finish** — A process for incorporating or adding flame retardant(s) to a material or product.

**3.7 Flame Resistance** — The property of a material whereby flaming combustion is prevented, terminated, or inhibited following application of a flaming or non-flaming source of ignition, with or without subsequent removal of the ignition source. The degree of flame resistance exhibited by a specific material during testing may vary with different test conditions.

**3.8 Flame-Resistant** — The material having flame resistance.

NOTE — 'Flame resistant' is a mandatory description for a product that meets established conformance standard when the product is tested by a specific method. Where no conformance standard exists, 'flame resistant' is a relative term and is used to compare one material with another.

**3.9 Flame-Proof Fabric** — A fabric which does not propagate flame; that is, any flame goes out quickly when the igniting flame is withdrawn.

**3.10 Glow** — Visible, flameless combustion of the solid phase of a material.



**3.11 After-Glow** — Persistence of glow in a material under specified test conditions, after the removal of an external ignition source or after the cessation ( natural or induced ) of flaming of the material.

**3.12 Duration of After-Glow ( After-Glow Time )** — The time for which a material continues to glow, under specified test conditions, after cessation of flaming, or, after removal of the ignition source.

**3.13 Extent of After-Glow** — The area of specimen in which the after-glow spreads beyond the area damaged by flaming.

**3.14 Duration of Flame ( After-Flame Time )** — The length of time for which a material continues to flame, under specified test conditions, after the ignition source has been removed.

**3.15 Char Length** — The distance from the edge of the specimen exposed to the flame under specified test conditions, to the upper edge of the charred section of the specimen, expressed in metric units.

**3.16 Raised Fabric** — A fabric with raised, brushed or napped surface or with cut or uncut pile.

**3.17 Unraised Fabric or a Fabric of Plain Surface** — A fabric having a surface significantly free from raised fibres, nap or pile.

#### **4. PRETREATMENT OF FABRIC**

**4.1** In order to determine the durability of a flame-retardant in case of treated fabrics, the specimens shall be subjected to leaching, washing, and/or dry cleaning treatments as described in Appendix A depending upon the end use.

**4.1.1** The selection of leaching, and/or dry cleaning treatments, the number of such treatments and their sequence shall be as agreed to between the buyer and the seller or as specified in the relevant material specification.

**4.1.2** In reporting the results of a test it shall be clearly stated whether the fabric was tested:

- a) without preliminary dry cleaning, leaching and washing procedures, or
- b) after specified dry cleaning procedures, or
- c) after specified leaching and/or washing procedures.

#### **5. SAMPLING**

**5.1** Sample for test shall be selected so as to be representative of the lot. Sample drawn in accordance with the material specification or as agreed to between the buyer and the seller shall be held to be representative of the lot.

## 6. METHOD A : VERTICAL FLAME TEST

**6.1 Principle** — A conditioned strip of fabric is suspended vertically and ignited at the base by flame impinging on both sides in a standard manner. After igniting the specimen for a specified period of time, the char length, after-flame and after-glow characteristics are noted.

### 6.2 Apparatus

**6.2.1** A means for providing the atmosphere for conditioning and testing ( see 6.3.1 and 6.3.2 ).

**6.2.2** The flammability tester consisting of:

- i) *Clip* — A suitable clip for suspending the test specimen above the flame.
- ii) *Shield* — An incombustible box  $305 \times 305 \times 760$  mm open at the top, and provided with a vertical transparent front. An opening, 25 mm deep and 125 mm long is left at the bottom of the front, to allow manipulation of the gas burner ( see Fig. 1 ).

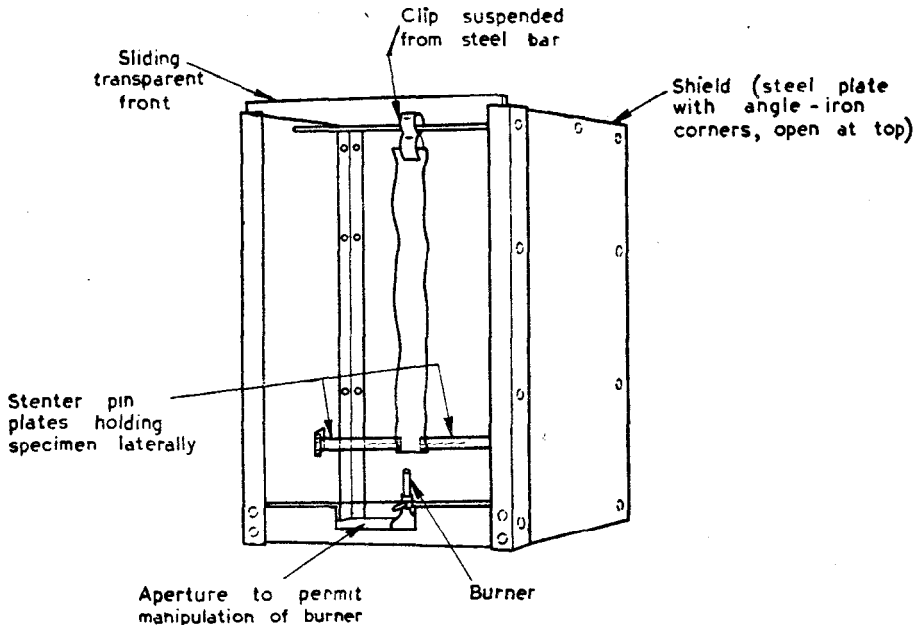


FIG. 1 APPARATUS FOR TESTING FLAMEPROOF MATERIALS

- iii) *Gas burner* — A Bunsen burner about 150 mm high with an internal diameter of 9 mm.
- iv) *Specimen holder* — Consisting of two U-shaped metal plates between which the fabric specimen can be held in such a way that the fabric specimen is free at the bottom and is held at the top and sides so that the total exposed area is  $50 \times 305$  mm. The specimen holder will be positioned in the draught-free box vertically so that the igniting flame strikes the specimen centrally and 19 mm above the bottom edge of the specimen.
- v) *Clamps* — These may be plain or serrated spring clips or small clamps. When made of smooth material, it may be necessary to insert emery paper to increase friction.
- vi) *Weights* — Weights such as are used with laboratory pan balances are satisfactory. A suitable pan may be made from a laboratory balance tray and wire.
- vii) *Stenter pin plates* — Two stenter pin plates, each consisting of a flat plate carrying pointed pins attached to one side of its broad surface, to prevent movement of the lower end of the test specimen during the application of the test flame. Each plate is secured at one end to the side of the shield in the horizontal position.

**6.2.3** *A stop-watch* — with an accuracy up to 0.1 second.

## 6.3 Conditioning and Testing Atmospheres

**6.3.1** *Conditioning* — Before testing, condition the specimens for 24 h in a standard atmosphere of  $65 \pm 2$  percent relative humidity and  $27 \pm 2^\circ\text{C}$  temperature ( see IS : 6359-1971\* ). If the test is not carried out immediately after conditioning, place the specimens in a tightly closed container until the commencement of the test. Each specimen shall be tested within two minutes of removing it from either the conditioning atmosphere or the container.

**6.3.2** *Testing Atmosphere* — Carry out the test in a substantially draught-free room or enclosure in an atmosphere of relative humidity between 20 to 80 percent and temperature between 20 to  $35^\circ\text{C}$ .

## 6.4 Test Specimens

**6.4.1** The test specimen shall be 315 mm long  $\times$  50 mm wide. It shall be prepared in accordance with **6.4.2**.

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\*Method for conditioning of textiles.

**6.4.2** Six specimens, where appropriate, three in warp direction and three in weft direction shall be cut from the sample ( **5.1** ) so as not to include selvage. ( *see* Note ). They shall be cut from three widely separated sections of the sample. The specimens shall be conditioned as specified in **6.3.1**.

NOTE — The test specimen should not have loose threads or any form of fringe along its edges, that might affect the ease of ignition, cause initial flaring or flashing and thus prejudice the test.

## 6.5 Procedure

**6.5.1** Keep the apparatus in a substantially draught-free room or enclosure ( *see* Note 2 ) having atmosphere as described in **6.3.2**. Suspend the test specimen from the clip so that it hangs vertically, with its lower end held by the horizontal stenter pin plates in such a way that the bottom 6 mm of the specimen is attached to the horizontal stenter pins thereon. The plates shall be so fixed that not more than 9 mm of the specimen on either side is covered by them.

NOTE 1 — In case of fabrics that shrink on burning, specimens may be mounted on suitable specimen holders so that the two long edges are held securely. In this case, the size of each specimen shall be 70 mm × 315 mm so that the total exposed area is 50 × 305 mm.

NOTE 2 — Because the test is carried out in a draught-free room, the air in the room is likely to become contaminated with the products of combustion. Where these products include potentially toxic substances, for example, hydrochloric acid, phosphorous compounds, etc, a mask or respirator capable of removing these substances should be worn, or the test may conveniently be carried out in a fume hood with the draught shut off. If obnoxious fumes are produced, these may be removed by turning on the draught between the test(s).

**6.5.2** Shut off the air supply to the gas burner completely and adjust to give a luminous flame 38 mm in length. Place the gas burner such that the base of the flame is 19 mm below the middle of the lower edge of the specimen. Apply the flame for a period of 12 seconds to the mid-point of the lower edge of the specimen and then withdraw the flame.

**6.5.3** Record the duration of flaming, extent of after-glow, the duration of after glow and occurrence of flashing over the specimen.

**6.5.4** When the after-glow has ceased, remove the test specimen from the clip and stenter pin plates and attach two clamps, one on each side of the charred area, 6 mm from lower edge of the test specimen. Attach a weight to one clamp gently so that combined weight is equal to about 10 percent of that required to tear the unburnt material. Measure the length of char or melt to the nearest 5 mm as the difference between

the original length of test specimen and the distance of the unexposed edge to the end of the tear made on the test specimen.

**NOTE 1** — If the material under test is made up of a thermoplastic fibre, it may be necessary to make a small cut vertically ( with a pair of scissors or razor blades ) through the area of resolidified polymer which extends round the charred areas. The clamps are then attached and the material is tested by the method as described above.

**NOTE 2** — In order to determine the weight required to tear the unburnt material, an unburnt specimen is laid on table and a cut, about 6 mm long, made in the middle of one end. A clamp is attached to the material on each side of the cut, and a weight is attached to the clamp on one side. The material is then gently lifted by the other clamp and the cut is observed. The process is repeated, if necessary, until the minimum weight necessary to tear the material is found. The combined weight of the clamp and attached weights is taken as the weight required to tear the unburnt material.

**6.5.4.1** Alternatively, the char length may be measured by the method prescribed in Appendix B.

## 6.6 Report

**6.6.1** Report the following separately for each specimen before and after the leaching, washing and/or dry cleaning treatments.

- a) Whether or not flashing occurs over the surface of the specimen;
- b) Duration of flame ( after-flame time ) in seconds;
- c) Duration of after-glow in seconds;
- d) Char length to the nearest 5 mm;
- e) Extent of after-glow; and
- f) Any abnormal behaviour occurring under the influence of the flame — for example, melting, dripping, shrinking from the flame and abnormal charring.

## 7 METHOD B : THE 45° FLAME TEST

**7.1 Principle** — Specimens cut from the textile are prepared by brushing if they have a raised fibre surface, by dry cleaning and laundering if they have a flame-retardant finish and by drying. The dried specimen of the fabric is held at an angle of 45° to the horizontal and a standardized flame is applied to the surface near the lower end for 1 s. The time required for flaming to proceed up the fabric a distance of 127 mm is measured. Ignition or fusing of the base of specimens having a raised fibre surface is noted.

## 7.2 Apparatus

### 7.2.1° *Flammability Tester*

**7.2.1.1 Draught-proof box** — Consisting of a ventilated draught-proof box ( 370 × 220 × 140 mm approx ) containing standard ignition mechanism and a specimen rack inclined at 45° and adjustable laterally so that the surface of the tested fabric will be at a standard distance from the micro-burner. For ventilation it shall be provided with 12 holes each 13 mm in diameter equidistantly spaced, near the top of the rear wall and by a slit 300 mm long and 13 mm wide ( or any equivalent ventilating strip ) below the sliding glazed door. The glazed door slides in grooves at the front of the cabinet. A knob moves the catch mechanism used to hold the sliding door in an open position for insertion of the specimen holders.

**7.2.1.2 Specimen rack** — It provides support for the frames in which the specimens are mounted. The angle of inclination is 45 degrees. Two guide pins projecting downward from the centre of the base of the rack, travel in slots provided in the floor of the chamber so that adjustment can be made for the thickness of the specimen in relation to the flame front. An indicating finger is provided, the forepart of which touches the specimen when the rack is correctly adjusted. Two control knobs hold the rack in test position. The knobs can be reached under the stage of the cabinet and permit forward and backward movements of the rack when loosened.

**7.2.1.3 Specimen holders** — Each specimen holder shall consist of two matched metal U-plates between which the fabric can be held in such a way that the fabric specimen is free at the bottom and is held at the top and sides with 40 mm of width and 150 mm of length exposed. The specimen holder shall be so made that it will drop on the specimen rack into a precisely determined position of 45° inclination and will be positioned in the specimen rack so that the igniting flame strikes the specimen centrally and 6 mm above the bottom edge. Five specimen holders are provided.

**7.2.1.4 Ignition mechanism** — The ignition mechanism shall comprise a micro-burner mounted on a rotatable spindle so that, at the commencement of each test, it moves to a position perpendicular to the surface of the fabric; the respective parts of the apparatus shall be so disposed that the end of the micro-burner is 8 mm above the upper surface of fabric. A flame 16 mm long shall be produced at the micro-burner by butane gas or petroleum gas ( see Note under 7.3.1 ) taken from a small cylinder, a sensitive reducing valve and a manometer device. The ignition mechanism provided shall be such that the flame is maintained

in the igniting position for the duration of the test. It shall be provided with means for the timing of the interval ( in seconds to the nearest 0.1 second ) from the moment of first impingement of the flame on the fabric specimen to the time when the weighed cotton thread is burnt through. The cotton thread is stretched from a guide ring through suitable thread guides provided on the specimen frame and chamber walls, permitting the lacing of the thread in the proper position exactly 127 mm from the point where the centre of the ignition flame impinges on the test specimen. A weight attached by means of a clip to the cotton thread, in dropping, actuates the stop motion.

**7.2.1.5 End Point** — The end point of the test is indicated by the burning through of a weighted cotton thread horizontally mounted across the specimen holder 127 mm from the point of ignition and not more than 6 mm above the surface of the specimen.

## 7.2.2 *Brushing Device*

**7.2.2.1 Movable carriage** — The brushing device consists of a base board over which a small carriage is drawn. This carriage runs on parallel tracks attached to the edges of the upper surface of the base board. A brush is hinged with pin hinges at the rear edge of the base board and rests on the carriage vertically with a pressure of 150 g. The carriage is so constructed as to receive the specimen in its holder and to permit its longitudinal brushing as the carriage is slowly moved beneath the weighted brush.

**7.2.2.2 Brush** — 40 mm long, comprising two rows of nylon monofil tufts 0.4 mm in diameter and 20 mm in length mounted in a staggered position. There are four tufts per 25 mm and each tuft contains 20 filament ends. The brush is mounted so that it may move freely in a vertical direction and is weighted so that it rests on a horizontal surface with a load of 150 g.

NOTE — For further details, ASTM D 1230-1972\* ( issued by the American Society for Testing and Materials ) may be referred.

**7.2.3 Laboratory Drying Oven** — maintained at  $105 \pm 3^{\circ}\text{C}$ .

**7.2.4 Desiccator** — 250 mm in diameter.

**7.2.5 Mercerized Cotton Sewing Thread** — corresponding to variety No. 20 of IS : 1720-1978†.

\*Standard test method for flammability of clothing textiles.

†Specification for cotton sewing threads ( second revision ).

**7.2.6 Worsted Test Fabric** — well scoured, undyed worsted cloth, plain weave, 170 to 180 g/m<sup>2</sup>.

### 7.3 Reagents

#### 7.3.1 Butane gas

NOTE — In place of butane gas, commercially available liquefied petroleum gas (LPG) may also be used.

#### 7.3.2 Calcium Chloride ( Anhydrous )

### 7.4 Test Specimens

**7.4.1** Five test specimens each measuring 150 × 50 mm shall be selected as given in 7.4.2 for each test and prepared as described in 7.4.3.

**7.4.2 Determination of the Type of Specimen** — Before specimens for the standard test are cut, establish by preliminary tests which type of specimen gives the highest observed burning rate. Conduct the preliminary tests as follows:

- a) *Unraised fabrics* — Test one specimen cut in the warp or length direction of the fabric and one cut in the weft or width direction. If there is a face side to the fabric these specimens shall be tested with the face side uppermost and two additional specimens shall be tested with the face side downwards.
- b) *Raised fabrics* — Fabrics raised on one surface only are always tested with the raised surface uppermost. Prepare two specimens cut in the warp direction, and test one with the lie of the nap or pile upwards and one with the lie downwards. Prepare two specimens cut in the weft direction and test these also in both directions with respect to the lie of the nap or pile.

**7.4.3 Preparation of Specimens** — Cut five specimens each of the type shown by preliminary tests ( see 7.4.2 ) and of size given in 7.4.1 and mark out on the surface opposite that to be tested, with the long dimensions in the direction in which burning is most rapid as established in the preliminary trials ( see 7.4.2 ).

NOTE — The end of each specimen towards which, and on the surface of which, flame spread is most rapid shall be identified by attaching a staple to it. The specimens shall then be cut from the fabric.

**7.4.3.1** Each specimen having a raised fibre surface shall be brushed once against the lay of the surface fibres with the brushing device. Other fibres do not require brushing.



**7.4.3.2** Condition the specimen in accordance with **7.5.1**.

## **7.5 Conditioning and Testing Atmospheres**

**7.5.1 Conditioning** — Dry the specimens for test, already cut and mounted in their holders, for 30 minutes in the ventilated drying oven maintained at  $105 \pm 3^\circ\text{C}$ . Cool each specimen, still in its specimen holder, in a desiccator or air-tight container over anhydrous calcium chloride for at least 15 minutes. Keep each specimen enclosed until immediately before the test.

**7.5.2 Testing Atmosphere** — Carry out the test in an atmosphere of relative humidity between 20 percent and 80 percent and temperature between  $20^\circ\text{C}$  to  $35^\circ\text{C}$ .

## **7.6 Procedure**

**7.6.1** Set up the flammability tester with its base horizontal. Adjust the specimen rack so that the surface of the fabric to be tested will be 6 mm from the end of the burner in its igniting position. Open the control valve of the fuel supply and allow approximately 5 minutes for the air to be driven from the fuel line. Ignite the gas and adjust the flame so that it burns steadily and has a length of 15 mm measured from the tip of the flame to the nozzle of the burner.

**7.6.2** Remove one fabric specimen from the desiccator and place it in position on the specimen rack. The test specimen should be ignited within 45 seconds of the time it was removed from the desiccator. Thread the detecting cotton thread (see **7.2.5**) through the guides and attach the weight to the cotton thread close to and just below the guide ring. Close the door of the apparatus. Set the stop watch at zero. Conduct the test in a draught-free room with the apparatus under conditions as described in **7.5.2**.

**7.6.3** Move the ignition flame to the igniting position and immediately start timing mechanism. Apply the flame to the specimen for a period of one second until the cotton thread is severed by the advancing flame. Timing is automatic, starting upon application of the flame and ending when the weight is released by the burning of the detecting cotton thread.

**7.6.4** Record the time of flame spread for each specimen and note whether the base of each specimen having raised fibre surface is ignited or fused to a point where the damage is apparent from the bottom of the specimen. Repeat the procedure until all the five specimens have been tested.

NOTE — The time of flame spread is the average time required for flaming to proceed up the fabric specimen to a distance of 127 mm.

**7.6.5** Calculate the average of the time of flame spread obtained for the five specimens.

**7.6.6** If average time of flame spread ( **7.6.5** ) is less than  $3\frac{1}{2}$  seconds or if some of the specimens do not burn, test five additional specimens. The time of flame spread of the fabric shall then be the average time for the ten specimens, or for the number of specimens that burn.

**7.7 Report** — The report shall include the following:

- a) Average time of flame spread for the five or ten specimens or for the number of specimens that burn before and after dry-cleaning or washing separately; and
- b) The ignition or fusing of the base fabric of textiles having a raised fibre surface when the base fabric of more than one of the five ( or two of the ten ) specimens tested ignites or fuses, before and after dry cleaning or washing separately.

## A P P E N D I X A

( *Clause 4.1* )

### LEACHING, WASHING AND DRY CLEANING TREATMENTS OF FABRICS

#### A-1. LEACHING TREATMENT

**A-1.1 General** — This treatment is applicable to non-apparel fabrics such as awnings, hatch covers and theatre curtains which would not normally be subjected to water or to dry cleaning in use but which might be subjected to spot cleaning or casual rinsing, for example, under a tap. It is also used as a preliminary treatment to the drycleaning procedure in order to remove water soluble finishes which, in use, may be affected by wetting. There is no objection to steeping together similar fabrics with the same finish.

**A-1.2 Specimens** — Use sufficient fabric to permit subsequent preparation of test specimens of the size and number required in Method A or B.

#### A-1.3 Reagents

**A-1.3.1 Water** — of  $160 \pm 20$  mg/l hardness ( expressed as calcium carbonate ) from one of the following sources:

- a) Supply water of  $160 \pm 20$  mg/l hardness.
- b) Supply water of higher than 180 g/l hardness and diluted to  $160 \pm 20$  mg/l hardness with water of lower hardness.

- c) Supply water of known initial hardness of ' $n$ ' mg/l where  $n$  is less than 140 mg/l and artificially hardened to  $160 \pm 20$  mg/l. To 5 litres of the water add 500 ml of the calcium chloride solution (see **A-1.3.2**) and follow this with 500 ml of the sodium hydrogen carbonate solution (see **A-1.3.3**) and then sufficient of the water to give a total of  $10 \pm 0.1$  litres.

**A-1.3.2 Calcium Chloride Hexahydrate** —  $43.8 (160 - n)$  mg/l solution in water of hardness  $n$  mg/l.

**A-1.3.3 Sodium Hydrogen Carbonate** —  $33.6 (160 - n)$  mg/l solution in water of hardness  $n$  mg/l.

**A-1.3.4 Non-ionic Wetting Agent** — Conforming to IS : 9458-1980\*.

NOTE — The exact nature of the wetting agent is not critical.

## **A-1.4 Apparatus**

**A-1.4.1 Flat-Bottomed Dish**

**A-1.4.2 Iron or Press** — to be used at a temperature setting not exceeding  $120^{\circ}\text{C}$ .

## **A-1.5 Procedure**

**A-1.5.1** Immerse each specimen in water (see **A-1.3.1**) containing 0.5 g/l of non-ionic wetting agent in the flat-bottomed dish at liquor ratio of 1 : 20 at a temperature of  $40 \pm 1^{\circ}\text{C}$ . After 30 minutes, remove the specimen, rinse in the water (see **A-1.3.1**) using a liquor ratio of 1 : 20 for 2 minutes, partially dry the specimens by any method suitable for the fabric type and then iron or press at a temperature setting not exceeding  $120^{\circ}\text{C}$ .

## **A-2. HARD WATER WASHING TREATMENT USING NEUTRAL SOAP OR SYNTHETIC DETERGENT SOLUTION**

**A-2.1 General** — This treatment is applicable to those fabrics which would normally be subjected to a water wash treatment in use.

**A-2.2 Specimens** — Use sufficient fabric to permit subsequent preparation of test specimens of the size and number required in Method A or B.

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\*Synthetic detergents for washing woollen and other delicate fabrics.

**A-2.3 Apparatus**

**A-2.3.1** A mechanical washing device, for example, wash-wheel sponsored by the Society of Dyers and Colourists or the launder-ometer sponsored by the American Association of Textile Chemists and Colourists ( *see also* IS : 1299-1984\* ). Whichever type of machine is used, the volume of the container should be at least twice that of the washing solution. All the material subjected to washing should be of the type under test; the use of other materials as loading material may give erroneous results.

**A-2.4 Reagents**

**A-2.4.1 Soap** — meeting the composition as specified in 7.1 of IS : 1299-1984\*.

**A-2.4.2 Non-ionic Wetting Agent** — based on ethylene oxide fatty alcohol condensate conforming to IS : 9458-1980†.

**A-2.4.3 Sodium Dihydrogen Phosphate** — anhydrous (  $\text{NaH}_2\text{PO}_4$  ).

**A-2.4.4 Disodium Hydrogen Phosphate** — anhydrous (  $\text{Na}_2\text{HPO}_4$  ).

**A-2.4.5 Hard Water** — with a hardness of  $160 \pm 20$  mg/l ( expressed as calcium carbonate ) ( *see* **A-1.3.1** ).

**A-2.5 Procedure**

**A-2.5.1** Treat the specimens in a suitable mechanical washing device ( *see* **A-2.3.1** ) as given in IS : 1299-1984\* for a period given in **A-2.5.3** with sufficient washing liquor containing 5 g/l soap ( *see* **A-2.4.1** ) and hard water ( *see* **A-2.4.5** ) to give a liquor ratio of 1 : 10 ( *m/m* ).

**A-2.5.2** Alternatively, instead of soap, a neutral synthetic detergent solution of following composition may be used: Sodium dihydrogen phosphate, anhydrous (  $\text{NaH}_2\text{PO}_4$  ) — 0.1 g/l. Disodium hydrogen phosphate, anhydrous (  $\text{Na}_2\text{HPO}_4$  ) — 0.2 g/l. Non-ionic wetting agent of the ethylene oxide fatty alcohol condensate type — 0.05 g/l. Hard water—to make the required volume.

NOTE — The pH of the solution in **A-2.5.2** shall be adjusted to  $7.0 \pm 0.2$ .

**A-2.5.3** Keep the washing conditions as follows:

Sl No.	Composition of Fabric	Solution Temperature	Washing Time, min
i)	Cotton and linen fibres	80 to 85°C or 60 to 70°C	30
ii)	Polyamide, polyester, regenerated cellulosic fibres	55 to 60°C	30
iii)	Wool, silk and acetate fibres	38 to 40°C	10
iv)	Acrylics, chlorofibres and modacrylic fibres	38 to 40°C	30

\*Method for determination of dimensional changes on washing of fabrics woven from rayon and synthetic fibres ( *second revision* ).

†Synthetic detergents for washing woollen and other delicate fabrics.

### A-3. SOFT WATER WASHING TREATMENT

**A-3.1 General** — This treatment is applicable to those fabrics employed in end uses to which laundering will be applied.

**A-3.2 Specimens** — Use sufficient fabric to permit subsequent preparation of test specimens of the size and number required in Method A or B.

#### A-3.3 Apparatus

**A-3.3.1 A Mechanical Washing Device** — ( see **A-2.3.1** ).

#### A-3.4 Reagents

**A-3.4.1 Water** — with a maximum hardness of 20 mg/l ( expressed as calcium carbonate ).

**A-3.4.2 Soap** — meeting the composition specified in **7.1** of IS : 1299-1984\* and containing 3% sodium carboxymethyl cellulose.

**A-3.4.3 Non-ionic Wetting Agent** — based on ethylene oxide condensate conforming to IS : 9458-1980†.

**A-3.4.4 Sodium Meta silicate** — conforming to IS : 9424-1979‡.

#### A-3.5 Procedure

**A-3.5.1** Treat the fabric in a suitable mechanical washing device by the procedure specified in IS : 1299-1984\* for a period and at a temperature given in **A-2.5.3** with sufficient washing liquor containing 5 g/l soap, 0.05 g/l non-ionic wetting agent, 3.5 g/l sodium metasilicate and soft water ( see **A-3.4.1** ) to give a liquor ratio of 1 : 10 ( *m/m* ).

### A-4. DRY CLEANING TREATMENT

**A-4.1 General** — This treatment is applicable to those fabrics which would normally be subjected to a dry cleaning treatment.

**A-4.2 Specimens** — Use sufficient fabric to permit subsequent preparation of test specimens of the size and number required in Method A or B.

#### A-4.3 Reagents

**A-4.3.1 Perchloroethylene or Petroleum Ether** — dry cleaning grade.

NOTE — Perchloroethylene should be stored over anhydrous sodium carbonate to neutralize any hydrochloric acid formed.

\*Method for determination of dimensional changes on washing of fabrics woven from rayon and synthetic fibres ( *second revision* ).

†Synthetic detergents for washing woollen and other delicate fabrics.

‡Sodium metasilicate.

#### A-4.4 Apparatus

**A-4.4.1** Suitable mechanical device consisting of a water bath containing a rotatable shaft which supports, radially, glass or stainless steel containers ( $75 \pm 5$  mm diameter  $\times$   $125 \pm 10$  mm high) of approximately  $550 \pm 50$  ml capacity, the bottom of the containers being  $45 \pm 10$  mm from the centre of the shaft. The shaft/container assembly is rotated at a frequency of  $40 \pm 2$  min<sup>-1</sup>. The temperature of the water bath is thermostatically controlled to maintain the test solvent at  $30 \pm 2^\circ\text{C}$ .

NOTE — Other mechanical devices may also be used for the test provided that the results are identical with those obtained by the apparatus described under **A-4.4.1**.

**A-4.4.2** Glass or stainless steel containers of approximately 550 ml capacity which shall be closed using solvent resistant gaskets.

**A-4.4.3** Non-corrodible ( stainless ) steel discs,  $30 \pm 2 \times 3 \pm 0.5$  mm, smooth and free from rough edges of mass  $20 \pm 2$  g.

#### A-4.5 Procedure

**A-4.5.1** Prepare a bag with inside dimensions of  $10 \times 10$  cm using the undyed cotton twill cloth by sewing together two squares of this cloth around three sides. Place the specimen and 12 steel discs inside the bag. Close the bag by any convenient means.

**A-4.5.2** Place the bag containing the specimen and the steel discs in the container and add 200 ml of dry cleaning solvent at  $30 \pm 2^\circ\text{C}$ . Treat the specimens for 30 minutes at  $30 \pm 2^\circ\text{C}$  in the specified mechanical device as specified in **A-4.4.1**.

**A-4.5.3** Remove the bag from the container, withdraw the specimens, place it between the absorbent paper or cloth and squeeze or centrifuge to remove surplus solvent. Dry the specimen by hanging it in air at a temperature not exceeding  $60^\circ\text{C}$ .

## APPENDIX B

( Clause 6.5.4.1 )

### MEASUREMENT OF CHAR LENGTH

#### B-1. APPARATUS

**B-1.1** A hook and weight assembly. The combined mass of the assembly should be as given in Table 1.

**TABLE 1 MASS TO TEAR CHARRED FABRIC**

Sl No.	MASS OF FABRIC BEING TESTED ( $g/m^2$ )	TOTAL MASS USED TO TEAR THE FABRIC
i)	Less than 200	100
ii)	200 to 600	200
iii)	Greater than 600	400

#### B-2. PROCEDURE

**B-2.1** Inspect the edge of the highest char penetration of the specimen to determine if as a result of thermoplastic behaviour, a thickening of the edge has developed. If this has occurred, make a cut after cooling, only sufficiently deep to cut through the highest portion of this thickened edge of the charred specimen.

**B-2.2** Fold the specimen parallel to its length and crease it lightly through the maximum visible portion of the charred length.

**B-2.3** Insert the hook with total mass as given in Table 1, in the specimen one side of the charred area, 8 mm in from the adjacent outside edge of the charred length.

**B-2.4** Grasp the specimen with fingers on the opposite side of the charred area and raise gently until it supports the weight. The fabric will tear through the area until fabric strong enough to carry the load is reached.

**B-2.5** Measure the distance from the end of the specimen which was exposed to the flame to the end of a tear made lengthwise in the specimen through the centre of the charred area, as the char length.

# INTERNATIONAL SYSTEM OF UNITS ( SI UNITS )

## Base Units

QUANTITY	UNIT	SYMBOL
Length	metre	m
Mass	kilogram	kg
Time	second	s
Electric current	ampere	A
Thermodynamic temperature	kelvin	K
Luminous intensity	candela	cd
Amount of substance	mole	mol

## Supplementary Units

QUANTITY	UNIT	SYMBOL
Plane angle	radian	rad
Solid angle	steradian	sr

## Derived Units

QUANTITY	UNIT	SYMBOL	DEFINITION
Force	newton	N	1 N = 1 kg.m/s <sup>2</sup>
Energy	joule	J	1 J = 1 N.m
Power	watt	W	1 W = 1 J/s
Flux	weber	Wb	1 Wb = 1 V.s
Flux density	tesla	T	1 T = 1 Wb/m <sup>2</sup>
Frequency	hertz	Hz	1 Hz = 1 c/s (s <sup>-1</sup> )
Electric conductance	siemens	S	1 S = 1 A/V
Electromotive force	volt	V	1 V = 1 W/A
Pressure, stress	pascal	Pa	1 Pa = 1 N/m <sup>2</sup>